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Perceived fit in activity-based work environments and its impact on satisfaction and performance[☆]

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ABSTRACT

Activity-based work environments are widely adopted; however, research shows mixed findings regarding privacy issues, satisfaction with the work environment, and task performance. To further our understanding, two complementary studies drawing on Person-Environment fit theory were conducted: (1) A field study using experience sampling, and (2) A lab study in a virtual reality studio. The results from both studies confirm that perceived fit is a function of activity, work setting, and personal need for privacy, with indirect effects on satisfaction with the work environment (Studies 1 and 2) and task performance (Study 2). Across both studies, a misfit was perceived particularly among workers high in personal need for privacy when performing high-complexity tasks in an open office work setting. Hence, we recommend that organizations facilitate and stimulate their workers to create better fits between activities, work settings, and personal characteristics.

1. Introduction

Growing numbers of organizations worldwide are adopting work environments based on the principles of Activity-Based Working (ABW) (Cushman & Wakefield, 2013; Leesman, 2017; Wohlers & Hertel, 2017). In these environments, workers do not have assigned workstations, but instead share an office space offering different types of non-assigned work settings, which are intended to be used for different types of activities (Becker, 1999; Jones Lang Lasalle, 2012; Veldhoen, 2005). A recent systematic review, based on seventeen field studies, found that an ABW environment may have merits with regard to social interaction, perceived control, and satisfaction with the work environment. However, an ABW environment seems to hamper workers' concentration and privacy (Engelen et al., 2018). Other studies have shown that satisfaction with ABW environments may differ strongly between and within organizations (Brunia, De Been, & Van der Voordt, 2016; Göçer, Göçer, Karahan, & Oygür, 2018; Hoendervanger, Ernst, Albers, Van Yperen, & Mobach, 2018; Leesman, 2017). In a number of field studies, satisfaction was below expectations, with concentration, privacy, and the loss of an assigned workstation listed as major self-reported issues (Babapour, 2019; Bodin Danielsson & Bodin, 2009; De Been & Beijer, 2014; Van der Voordt, 2004).

Hence, in this paper, we present two complementary studies that were aimed at explaining these mixed outcomes of ABW environments. The basic rationale underlying ABW is that, when offered different types of work settings, workers will use these in accordance with their activities and needs (Becker, 1999; Gibson, 2003). Similarly, Person-Environment (PE) fit theory defines PE fit as a match between workers' characteristics, their work environment, and their tasks (Edwards, Caplan, & Harrison, 1998; Kristof-Brown, Zimmerman, & Johnson, 2005). Hence, we assume that a (perceived) fit between work settings, activities, and workers' personal needs produces positive outcomes such as satisfaction and performance (Vischer, 2007; Wohlers & Hertel, 2017). Three recent studies conducted in ABW environments provide initial empirical support for the link between (perceived) fit and positive outcomes (Gerdenitsch, Korunka, & Hertel, 2017; Haapakangas, Hongisto, Varjo, & Lahtinen, 2018; Wohlers, Hartner-Tiefenthaler, & Hertel, 2017).

Drawing on PE fit theory, the current studies were designed to further examine when and why ABW environments do (not) work. In line with PE fit theory (Edwards et al., 1998; Kristof-Brown et al., 2005), we expected a worker's personal need for privacy (PNP) to moderate perceived fit between activity and work setting. Consistent with previous findings (Gerdenitsch et al., 2017; Kristof-Brown & Guay,

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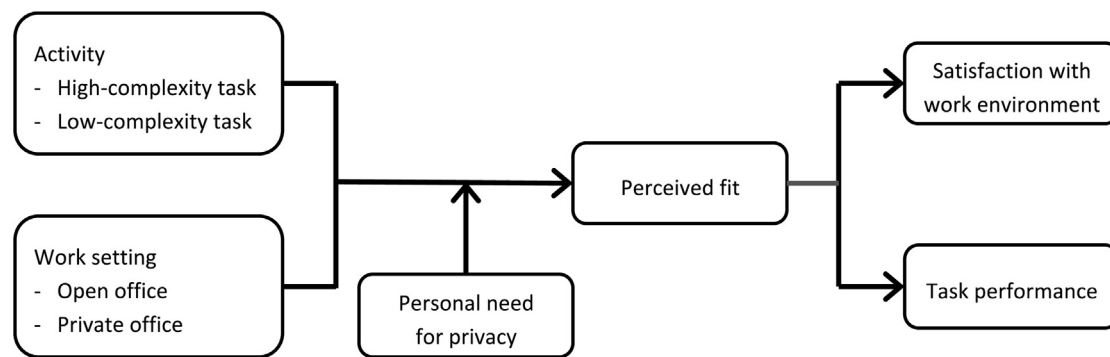


Fig. 1. Research model. Note that Task performance could only be assessed and tested in Study 2.

2011), we assumed perceived fit to be related to important organizational outcomes of satisfaction with the work environment (Studies 1 and 2) and task performance (Study 2). Note that we specifically focused on high-complexity versus low-complexity tasks to gain a better understanding of often-reported privacy and concentration issues (Babapour, 2019; Bodin Danielsson & Bodin, 2009; De Been & Beijer, 2014; Engelen et al., 2018; Van der Voordt, 2004).

To test our research model (see Fig. 1), we conducted two complementary studies. In Study 1, a field study with a high level of ecological validity, we examined the actual use of private and open office work settings for high-complexity versus low-complexity tasks and related experiences of fit. In line with the recommendations of Davis, Leach, and Clegg (2011), we used experience sampling (Larson & Csikszentmihalyi, 1983; Totterdell, 2006) to collect detailed and reliable data, and to address potential recall bias (Shiffman, Stone, & Hufford, 2008) associated with unconscious automated behavior (Aarts & Dijksterhuis, 2000). In Study 2, a laboratory experiment, we relied on virtual reality (VR) to simulate the typical working conditions of a private and an open office work setting. Under these controlled conditions, we were able to test the causal relations between activity and work setting (independent variables), PNP (moderator), and satisfaction with the work environment and objectively measured task performance (dependent variables). To our knowledge, this is the first experimental study to test the basic assumption underlying the ABW concept drawing on PE fit theory: that is, a (perceived) fit between activity and work setting produces positive outcomes.

1.1. Perceived fit as a function of activity and work setting

In our studies, we focused on two common types of (unassigned) work settings that offer high versus low levels of privacy and concentration: A private office, or workstation in an enclosed individual room (sometimes referred to as ‘concentration cell’), and an open office, that is, a workstation in an open-plan area. We specifically selected these two types of work settings because they can be considered as extreme opposites in terms of privacy offered, whereas other types offer moderate or varying privacy levels (e.g., semi-enclosed workstations, shared rooms for quiet working). As task complexity is directly linked to the required level of concentration (Bedny, Karwowski, & Bedny, 2012), the rationale underlying ABW is that private office and open office work settings fit with high-complexity tasks (e.g., writing a business case report, reviewing a complex contract) and low-complexity tasks (e.g., answering simple e-mails, reading news letters), respectively. Conversely, the use of private office work settings for low-complexity tasks and the use of open office work settings for high-complexity tasks are considered to be misfits. In terms of PE fit theory, to create need-supply fit, the activity-induced need (e.g., the need to concentrate) should be fulfilled by the work setting (Edwards et al., 1998; Kristof-Brown et al., 2005).

With regard to high-complexity tasks, numerous studies indeed

suggest a better perceived fit with private office rather than open office work settings (e.g., Compennolle, 2014; De Been & Beijer, 2014; Kaarlela-Tuomaala, Helenius, Keskinen, & Hongisto, 2009; Kim & De Dear, 2013). For example, workers who rated their job as requiring high concentration were found to experience lower levels of environmental distraction and stress in cell offices compared with open-plan offices (Seddigh, Berntson, Bodin Danielson, & Westerlund, 2014). Other studies showed that, particularly among workers in highly complex jobs, working in open-plan offices was negatively associated with satisfaction, workplace attitudes, withdrawal behaviors, and performance (Block & Stokes, 1989; Mahler & Von Hippel, 2005; Sundstrom, Burt, & Kamp, 1980).

With regard to low-complexity tasks, Compennolle (2014) suggested that routine work fits better with an open-plan environment because “.... some distraction helps to prevent this work from becoming too boring and increases the performance and feeling of wellbeing” (p. 24). This idea is in line with arousal theory, which suggests that a certain level of arousal, which may be caused by ambient noise, is required for optimal task performance (Staal, 2004). Similarly, based on a literature review, Hockey (1979) concluded that performance improvement from noise exposure is often seen in less complex tasks or those in which boredom is experienced, while negative effects are more likely in complex tasks. However, to date, the empirical evidence is limited and contradictory. McBain (1961) found that the performance of monotonous work improved with exposure to certain types of noise (i.e., low in intelligibility, high in variability). Likewise, in a laboratory study, workers performed better at routine tasks in a shared office (with three co-workers) compared with a private office (Block & Stokes, 1989). In contrast, in a field study by Sundstrom et al. (1980), the hypothesis that performance and satisfaction would be higher when routine work was carried out in non-private work settings, was rejected; private rooms were preferred for all types of work.

1.2. Personal need for privacy (PNP) as a moderator

In addition to task characteristics, individual differences among workers seem to be important as well. In line with PE fit theory (Edwards et al., 1998; Kristof-Brown & Guay, 2011), and other organizational theories that recognize the importance of individual differences (e.g., Hackman & Lawler, 1971; McClelland & Burnham, 1976), the preference for a particular work setting when working on a particular task may be a function of individual differences (Van Yperen & Wörtler, 2017). With regard to office design, Oseland (2009) argued that both task requirements and psychological needs should be addressed. In the present research, we propose that particularly for workers high in PNP, a private office work setting may lead to more favorable outcomes, particularly when high-complexity tasks are carried out. PNP was introduced and conceptualized by McKechnie (1977) as an individual's preference for protection from unwanted external interruptions and distractions (rather than protection from sharing

confidential information, being overheard, or being watched; Kupritz, 1998). For example, Oldham (1988) found that people high in PNP preferred working in closed, preferably individual rooms rather than working in an open-plan office. In a more recent field study, it was found that workers high in PNP generally reported lower satisfaction with ABW environments Hoendervanger et al., 2018. Accordingly (see also Fig. 1), we expected to find a moderation effect of PNP such that perceived fit between open office work settings and high-complexity tasks would be low, particularly among workers high in PNP. Conversely, we expected perceived fit between open office work settings and low-complexity tasks to be high, particularly among workers low in PNP.

1.3. Indirect effects on satisfaction with the work environment and task performance

PE fit theory states that a perceived misfit between personal needs (e.g., PNP) and environmental supply (e.g., privacy offered by the work setting) causes psychological strain such as dissatisfaction (Edwards et al., 1998; Kristof-Brown et al., 2005). Accordingly, Wohlers and Hertel (2017) proposed that when workers are using work settings “according to their task's needs [...] high Task-Environment fit decreases negative effects of acoustic disturbances and distractions” (p. 475). Initial empirical support for this relationship was found by Gerdenitsch et al. (2017). They showed that, after relocation to an ABW environment, workers reporting higher levels of perceived fit between activities and work settings demonstrated a stronger increase in satisfaction with their work environment. Hence, we expected an interactive, indirect effect of activity, work setting, and PNP on satisfaction with the work environment through perceived fit.

As noted by Wohlers and Hertel (2017), PE fit theory suggests that also task performance may be affected by a (mis)match between personal needs (which may be induced by the task at hand) and the work environment (cf., Edwards et al., 1998). In the PE fit literature, person-organization fit and person-job fit are typically positively associated, albeit weakly, with task performance (Kristof-Brown & Guay, 2011), a finding that has been supported in workplace research as well (e.g., Block & Stokes, 1989; Mahler & Von Hippel, 2005; Sundstrom et al., 1980). Hence, we expected activity, work setting, and PNP to have an interactive indirect effect on task performance through perceived fit.

2. Methods of study 1

2.1. Sample

Data were collected in a Dutch organization, found within the researchers' network, that agreed to cooperate by allowing workers to take part in the research on a voluntary basis. The organization is a large public organization (around 500 workers) employing knowledge workers mainly. A total of 61 workers participated in the study (51% male; average age 46.2 years; educational attainment: 38% master's degree or higher). The work environment, which had been in use for more than two years, was based on the ABW concept, providing different types of work settings, i.e., open-plan workstations, private rooms, meeting rooms, open meeting places, lounge workstations, and telephone booths. These work settings were designed for different types of activities and were not assigned to individual workers (free seating). The desk-sharing ratio was 1.2 persons per desk, with 12% of the desks situated in private office work settings.

2.2. Procedure

All workers were informed about the purpose and the procedure via intranet and an e-mail inviting them to attend a presentation session if they were interested in participating. About a week before the start of the measurement period, they all received an e-mail invitation.

Following the link in this e-mail, they could first fill out an online questionnaire in which their PNP and satisfaction with the work environment were assessed. Next, they could install a mobile application on their smartphone or tablet. We tested and optimized the application before using it in the current study Hoendervanger, Le Noble, Mobach, & Van Yperen, 2015. During the measurement period of two weeks (10 working days), at six randomly chosen times during office hours, participants received a request (push notification) to answer three straightforward questions. Participants could answer these questions right away or later the same day (until midnight). The research procedure was reviewed and approved by the Ethical Committee Psychology of the University of Groningen.

2.3. Measures

Activity and perceived task complexity were measured repeatedly through the experience-sampling application. Answering the question “I'm currently working on ...”, participants could select from a list of pre-defined options. Two of these options were included in this study: “individual work that requires a high level of concentration” (coded as 0) and “individual work that requires a low level of concentration” (coded as 1). The answers to this question should be considered as subjective judgments of the required level of task-related concentration, which may be influenced by comparisons with implicit social or psychological standards (Edwards, Cable, Williamson, Schurer Lambert, & Shipp, 2006). Since perceived task complexity is directly linked to the perceived level of concentration that the task requires (Bedny et al., 2012), we used this measure as an indicator for perceived task complexity.

Work setting was measured repeatedly using the experience-sampling application. Answering the question “I'm currently working at/on/in ...”, participants could select from a list of pre-defined options based on the actual range of choice of work settings and the terms that were used in that organization. Two of these options were included in this study: “workstation in open plan” (coded as 0) and “workstation in closed private room” (coded as 1).

Personal need for privacy (PNP) was measured at the outset using five items derived from the Environmental Response Inventory (Bruni, Schultz, & Saunders, n.d.; McKechnie, 1977): (1) “I get irritated when colleagues are noisy”, (2) “I have difficulty concentrating when things are noisy”, (3) “I am easily distracted by people moving about”, (4) “I need complete silence”, (5) “I get distracted easily”. Scores ranged from 1 (*do not agree at all*) to 5 (*very strongly agree*). Cronbach's alpha in our sample was .87.

Perceived fit between activity and work setting was measured repeatedly using the experience-sampling application. Participants reported to what extent they agreed with the statement “I can carry out this activity well at this workstation” using a six-point scale, ranging from “very strongly disagree” (coded as 1) to “very strongly agree” (coded as 6). This measure is similar to measures typically used in PE fit studies (Kristof-Brown & Guay, 2011) and in line with the ‘molar’ approach introduced by Edwards et al. (2006). Use of a single-item measure was desirable to keep the experience-sampling questionnaire as short as possible. This is acceptable because perceived fit is a sufficiently narrow and unambiguous construct (Wanous, Reichers, & Hurdy, 1997).

Satisfaction with the work environment was measured at the outset using the question “How do you rate your satisfaction with the work environment?” (1 = lowest rate, 10 = highest rate). A single-item measure was used to minimize the burdening of participants during working time. This is acceptable because workplace satisfaction is a sufficiently narrow and unambiguous construct (Wanous et al., 1997).

2.4. Statistical analyses

An ordinal probit regression model was constructed to analyze

perceived fit between activity and work setting as a function of activity, work setting, and PNP. Linear regression analysis was not possible due to the use of a single-item measure for the dependent variable, perceived fit. In line with our research model (see Fig. 1), main effects, two-way interactions, and the three-way interaction were included. Since activity, work setting, and perceived fit were measured repeatedly per individual, whereas PNP was administered once per individual, a hierarchical model with two levels was used. The resulting model is a generalized linear mixed model, which was fit through Bayesian MCMC using the MCMCglmm package (Hadfield, 2010) in R (R Core Team, 2015). Follow-up simple slope analyses (Aiken & West, 1991) were used to interpret interaction effects.

In Study 1, we followed the procedure proposed by Baron and Kenny (1986) to test the expected mediation effect through perceived fit on satisfaction. The more advanced approach introduced by Hayes (2017a), which we used for the lab study (Study 2), was not readily applicable to our ordinal-probit regression model. We set up two single-level weighted least squares regression models, linking the percentage of time spent on high-complexity tasks, the percentage of time spent in an open office work setting, the need-for-privacy score, and the average perceived-fit score to the reported satisfaction level for each individual participant. The numbers of entries per participant were used as weights.

3. Results of study 1

3.1. Descriptive statistics

A total of 2306 measurements were collected. The time gap between sending out the questions and receiving the answers was less than 1 h in 69% of the cases, and more than 5 h in 6% of the cases ($M = 56$ min; $m = 33$ min; $SD = 0.09$). For our analyses, we selected the 975 measurements that concerned the reported use of a workstation in an open office or a private office work setting for an individual work activity (high- or low-complexity task). This subset comprised 42% of the measurements; the rest concerned work outside the office, commuting and time off (32%), communication activities and breaks (24%), and individual activities carried out in work settings other than open office and private office (2%).

The observed frequencies for the variables activity and work setting showed that most individual work concerned high-complexity tasks (58%). Remarkably, almost all of this work was performed in open office work settings (93%). As a consequence, misfits between activity and work setting were a common phenomenon, but only with regard to high-complexity tasks. Specifically, 52% of the measurements concerned high-complexity tasks in open office work settings, and only 1% of the measurements concerned low-complexity tasks in private office work settings. Note that there was a substantial discrepancy between the proportion of private office work settings (12%) and the proportion of reported high-complexity tasks (58%).

Table 1 shows descriptive statistics for the three continuous variables: (1) PNP, (2) perceived fit, and (3) satisfaction with the work environment. As expected, a significant positive correlation between perceived fit and satisfaction with the work environment was found. Furthermore, PNP was significantly negatively associated with both perceived fit and satisfaction.

Table 1
Means, standard deviations, and correlation coefficients (Study 1).

Variable	Mean	SD	1	2
1. Personal need for privacy (PNP)	2.62	0.85	–	
2. Perceived fit between activity and work setting	4.58	0.86	-.65* [-.77, -.47]	–
3. Satisfaction with the work environment	6.91	1.58	-.60* [-.74, -.41]	.61* [.42, .75]

Note. Average scores are used for perceived fit. Pearson correlation coefficients with 95% confidence intervals; * $p < .01$.

Table 2

Results of ordinal probit regression analysis for perceived fit (Study 1).

Source of variation	Coefficient	95% confidence interval		p-value
		Lower	Upper	
Activity	2.938	2.609	3.249	< .001
Work setting	5.388	4.653	6.008	< .001
Personal need for privacy (PNP)	–1.378	–1.816	–0.950	< .001
Activity × work setting	–8.925	–10.377	–7.559	< .001
Activity × PNP	0.168	–0.099	0.431	.221
Work setting × PNP	1.148	0.503	1.754	< .001
Activity × work setting × PNP	–2.250	–3.437	–1.040	< .001

Note. The regression coefficients have no natural interpretation as these are measured on a probit-scale; however, the signs of these coefficients indicate the directions of the relations.

3.2. Perceived fit as a function of activity, work setting, and personal need for privacy (PNP)

The results of the ordinal probit regression analysis are presented in Table 2. The p values indicate that all main effects and interaction effects are significant, except for the interaction effect of activity × PNP. The significant main effects and two-way interaction effects were qualified by the significant three-way interaction effect of activity × work setting × PNP. In line with our research model (see Fig. 1), follow-up analyses revealed a significant slope difference ($p < .001$) for the high-complexity task condition (see Fig. 2a). Furthermore, perceived-fit scores for high-complexity tasks were significantly higher in the private office work settings compared with the open office work settings ($p < .001$). A significant negative slope for the open office condition ($p < .001$) indicates that, as expected, perceived fit between high-complexity tasks and open office work settings was particularly low among workers high in PNP.

We also found a significant slope difference ($p = .001$, see Fig. 2b) for the low-complexity task condition. As expected, in contrast with the high-complexity tasks, perceived-fit scores for low-complexity tasks were significantly higher in the open office work settings compared with the private office work settings ($p < .001$). The significant slopes ($p < .001$) indicate that, compared with workers low in PNP, workers high in PNP reported significantly lower perceived fit in both open and private office work settings.

3.3. Indirect effect on satisfaction with the work environment

Two regression models were compared to test the hypothesized indirect effect on satisfaction with the work environment. The first model included activity, work setting, PNP, perceived fit, and all mutual interactions. The second model resulted after the presumed mediator, perceived fit, was removed from the first model. The model fit of the first model ($R^2 = 0.60$, $R^2_{Adjusted} = 0.47$, $F(15, 45) = 4.58$, $p < .001$), compared with that of the second model ($R^2 = 0.43$, $R^2_{Adjusted} = 0.36$, $F(7, 53) = 5.8$, $p < .001$), was significantly better ($\Delta R^2 = 0.17$, $F(8, 45) = 2.42$, $p = .028$).

Our results meet the four conditions for a mediation effect according to Baron and Kenny (1986): (1) as demonstrated in the previous section,

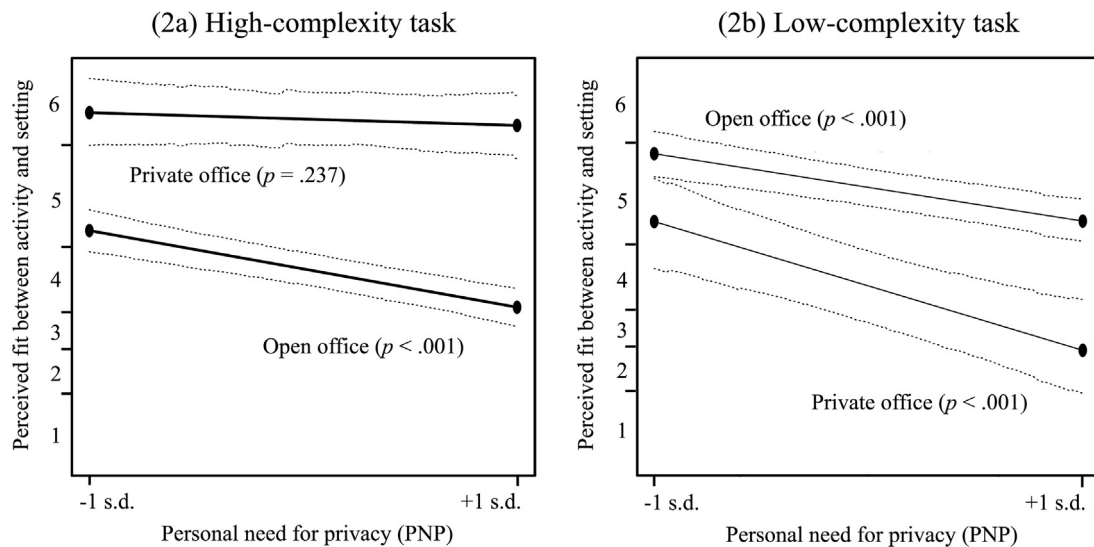


Fig. 2. Interactive effects of activity, work setting, and personal need for privacy (PNP) on perceived fit with 95% credible bands (Study 1). On the vertical axis, perceived fit scores ranged from 1 to 6 (the width of the intervals varies as a result of the ordinal probit regression analysis). The horizontal axis shows the PNP scores, ranging from 1 s.d. below to 1 s.d. above average.

Note. Slope differences were significant for high-complexity tasks ($p < .001$) and low-complexity tasks ($p = .001$). Scores for private and open office work settings differed significantly for both high-complexity and low-complexity tasks (p -values $< .001$).

perceived fit is a function of activity, work setting, and PNP, (2) the second model demonstrates a significant total effect on satisfaction, (3) a significant main effect of perceived fit was observed in the first model ($\beta = -20.84$, 95% CI $[-39.66, -2.02]$, $t(45) = -2.23$, $p = .031$), and (4) the three-way interaction effect of activity \times work setting \times PNP was weaker in the first model ($p = .799$) than in the second model ($p = .118$). Hence, activity, work setting, and PNP had a significant interactive indirect effect on satisfaction with the work environment, through perceived fit. The adjusted R^2 value of the second model indicates that 36% of variance in satisfaction can be ascribed to the (interactive effects of the) independent variables.

4. Discussion of study 1 and introduction of study 2

The results from Study 1 show that, in line with our research model (see Fig. 1), perceived fit was a function of activity, work setting, and PNP, with an indirect effect on satisfaction with the work environment. Perceived fit scores for *high-complexity tasks* were higher when a private office work settings were used and, in contrast, perceived scores for *low-complexity tasks* were higher when open office work settings were used. Except when high-complexity tasks were carried out in a private office work setting, workers high in PNP consistently reported lower perceived fit compared with workers low in PNP. After describing the methods and results of Study 2, we will compare and integrate these findings with those of Study 2, which is based on the same research model (with the addition of task performance as an outcome variable).

Study 1 was a field study with a high level of ecological validity but it does not allow causal inferences. Therefore, in Study 2, a laboratory experiment, we relied on VR to simulate the typical working conditions of a private and an open office work setting. Under these controlled conditions, we were able to test the causal relations between activity and work setting (independent variables), PNP (moderator), and satisfaction with the work environment and objectively measured task performance (dependent variables). In other words, in an experimentally controlled virtual reality studio, we tested the same research model (see Fig. 1), with task performance as an additional outcome variable.

5. Methods of study 2

5.1. Sample

All participants of the lab experiment in the VR studio were first-year students in a bachelor's program in Facility Management at Hanze University of Applied Sciences in the Netherlands. Of the original 204 participants, 44 were excluded from the dataset for different reasons. Twenty-five students who indicated having dyslexia were excluded as this might have affected their task performance. One student who appeared to be familiar with the Indonesian language was excluded since one of the tests was in that language, to prevent participants from getting distracted by the content. Eighteen other students were excluded because of incomplete data (e.g., due to skipping questions, misinterpretation of task instructions, or errors in time keeping). The remaining 160 participants (59% female) ranged in age from 17 to 29 years ($M = 19.48$, $SD = 2.03$).

An a priori power calculation, using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007), revealed that a medium effect size (Cohen's $f = 0.25$) could be detected at the 80% power level when the sample size is at least 128. With the $n = 160$ participants, a power level of 88% for a medium effect size ($f = 0.25$) is feasible (Faul et al., 2007).

5.2. Procedure

The participants were randomly assigned to a one of four conditions in a 2 (Work setting: Private versus Open office) \times 2 (Activity: High-versus Low-complexity task) between-subjects design: (1) private office, high task complexity ($N = 39$), (2) private office, low task complexity ($N = 39$), (3) open office, high task complexity ($N = 41$), (4) open office, low task complexity ($N = 41$). The research procedure was reviewed and approved by the Ethical Committee Psychology of the University of Groningen.

The experiment took place in a VR studio on the university campus. In an adjacent room the participants received a written explanation of the procedure, provided their informed consent, and filled out the need-for-privacy questionnaire (McKechnie, 1977). For the actual experiment, participants were guided to a workstation (chair and desk with computer screen and mouse) that was placed inside the 'Reality Cube': A half-open cube whose sides were 2.5 m long. Stereo 3D images were



Fig. 3. Simulated conditions in the 'Reality Cube' (Study 2).

projected from outside on to the three vertical sides. Participants wore shutter glasses, which allowed them to see depth in the projected images. Also, they wore a cap with a sensor, which enabled the system to draw the images on screen from the perspective of the participant. This technology creates a highly realistic, 'immersive' experience (Loomis, Blascovich, & Beall, 1999; Smith, 2015).

The private and open office conditions were simulated by putting participants in corresponding parts of a 3D model of an existing ABW environment, i.e., a private room measuring 1.8 m by 3.6 m with one workstation versus an open area with 15 workstations; see Fig. 3. Animated human figures and recorded office sounds (i.e., primarily babble, some laughing; intelligibility of speech was very low) were added to further enhance the realism of the experience. In the private office condition, human figures could be seen walking by in the adjacent corridor through a semi-transparent part of the wall, and L_{Aeq} was between 25 dB and 30 dB (i.e., simulating sounds in an adjacent room, barely audible through the wall). In the open office condition, some human figures were working at desks and others were walking across the open space or standing at the coffee machine, and L_{Aeq} was between 50 dB and 60 dB. Climate conditions were monitored and kept constant throughout the experiment (i.e., temperature 21–23 °C, humidity 30–40%, CO₂ level 450–500 ppm).

Sitting at the workstation, participants completed either the high- or the low-complexity versions of two different tasks, using a mouse and computer screen. Task 1 was based on the Minnesota Clerical Test (Bubany & Hansen, 2006), and Task 2 was a letter-search task. Both tasks are described in more detail below. After the first task, we assessed perceived task complexity (manipulation check) and perceived fit. After the second task, the same questions were answered as after the first task, followed by questions regarding perceived privacy (manipulation check) and satisfaction with the work environment. The tests were timed at 3 min each; the entire procedure in the VR studio took 12–14 min per participant. A research assistant was present to receive and to guide the participants, to provide the materials, and to monitor the process.

5.3. Measures

5.3.1. Perceived task complexity (manipulation check)

The following three items were developed for the current research to check the effectiveness of the activity manipulation (i.e., high versus low task complexity): "The task I just completed ..." (1) "was simple" (reversed), (2) "was complex", (3) "was difficult". Scores ranged from 1 (*do not agree at all*) to 7 (*very strongly agree*). The average of the two scores (i.e., related to the first and the second task) was used to create one overall perceived-task-complexity score. Cronbach's alpha was .62 after the first task (3 items), 0.77 after the second task (3 items), and 0.74 for the overall score (6 items).

5.3.2. Perceived privacy (manipulation check)

The following five items were developed for the current research to

check the effectiveness of the work-setting manipulation (i.e., private versus open office): "I carried out tasks at a workplace ..." (1) "in a quiet environment", (2) "that provides a lot of privacy", (3) "in a noisy environment" (reversed), (4) "where I can concentrate well", (5) "with a lot of distraction" (reversed). Scores ranged from 1 (*do not agree at all*) to 7 (*very strongly agree*). Cronbach's alpha was .91.

5.3.3. Personal need for privacy (PNP)

As in Study 1, we used five items from the environmental response inventory (Bruni et al., n.d.; McKechnie, 1977) to measure PNP. Cronbach's alpha was .72.

5.3.4. Perceived fit between activity and work setting

In Study 2, we were able to use a multi-item scale to measure perceived fit. For this purpose, the following five items were developed: "The task that I just carried out ..." (1) "was doable at this workplace", (2) "was undoable at this workplace" (reversed), (3) "I would have done better at a different workplace" (reversed), (4) "I could not do well at this workplace" (reversed), (5) "I could do well at this workplace". For one participant who skipped one of these items, we used the remaining four items to calculate the perceived-fit score. Scores ranged from 1 (*do not agree at all*) to 7 (*very strongly agree*). The average of the two scores (i.e., related to the first and the second task) was used to create one overall perceived-fit score. Cronbach's alpha was .86 after the first task (5 items), 0.89 after the second task (5 items), and 0.91 for the overall perceived-fit score (10 items).

5.3.5. Satisfaction with the work environment

In Study 2, we were able to use a multi-item scale to measure satisfaction with regard to three aspects of the work environment that were adapted from the WODI (Work Environment Diagnostic Instrument) (Maarleveld, Volker, & Van der Voordt, 2009): (1) comfort, (2) productivity support, and (3) functionality. A ten-point response scale was used, ranging from 1 (*very dissatisfied*) to 10 (*very satisfied*). Cronbach's alpha was .82.

5.3.6. Task performance

Two different cognitive tasks were used to measure task performance. In the first task, based on the Minnesota Clerical Test (Bubany & Hansen, 2006), two lists of meaningless codes (random combinations of letters and numbers) were presented on the screen. The participants were asked to mark all lines (and only those lines) in which both codes (left and right) were identical. In the low-complexity version, all codes consisted of six characters; in the high-complexity version, all codes consisted of ten characters. Participants could use the mouse to mark lines and to scroll to the next page to continue until the 3 min were over. Scores were determined by summing up the number of correct marks and subtracting the number of incorrect marks.

In the second task, a letter-search task, participants were asked to mark (with the mouse) specific letters in a text presented on the computer screen, e.g., "In the text below, mark all lower-case letters 'd'".

Indonesian texts were used to prevent participants from getting distracted by the content (non-familiarity with Indonesian language was checked beforehand). In the high-complexity version, the targets were three different letters that had to be marked simultaneously. In the low-complexity version, the target was only one letter. Participants could scroll to the next page to continue until the time was up. Test scores were determined by summing up the number of correct marks and subtracting the number of incorrect marks (i.e., wrong letters).

To create one overall task-performance score, the scores on each task were transformed into Z-scores. The average Z-score was used as overall index for participants' task performance.

5.4. Statistical analyses

In Study 2, a linear regression model was constructed to analyze perceived fit as a function of activity, work setting, and PNP, including their mutual interactions. Follow-up simple slope analyses (Aiken & West, 1991) were used to interpret interaction effects.

A regression-based approach, developed by Hayes (2017a, 2017b), was used to analyze the indirect effect of activity, work setting, PNP, and their mutual interactions on satisfaction, through perceived fit ('moderated mediation' according to Hayes' Model 12).

6. Results of study 2

6.1. Descriptive statistics

Table 3 presents the means, standard deviations, and correlation coefficients of all continuous variables. As expected, perceived fit was significantly positively correlated with satisfaction with the work environment and task performance. The correlation between satisfaction and task performance was not significant.

6.2. Manipulation checks

6.2.1. Perceived task complexity

A two-sided *t*-test revealed that compared with the participants in the low-complexity task condition ($M = 2.87$, $SD = 0.84$), the participants in the high-complexity task condition ($M = 3.32$, $SD = 0.91$) scored significantly higher on perceived task complexity (mean difference = -0.45 , 95% CI $[-0.72, -0.18]$, $t(158) = -3.28$, $p = .001$), as intended.

6.2.2. Perceived privacy

A two-sided *t*-test showed that also the manipulation of the work setting was successful. Compared with the participants exposed to the open office condition ($M = 3.69$, $SD = 1.20$), the participants exposed to the private office condition ($M = 5.46$, $SD = 1.01$) scored higher on perceived privacy (mean difference = 1.77 , 95% CI $[1.42, 2.12]$, $t(158) = 10.07$, $p < .001$).

6.3. Perceived fit as a function of activity, work setting, and personal need for privacy (PNP)

As in Study 1, results from the regression analysis show that the

Table 3
Means, standard deviations, and correlation coefficients (Study 2).

Variable	M	SD	1	2	3
1. Personal need for privacy (PNP)	3.01	0.72	–		
2. Perceived fit between activity and work setting	5.46	0.94	-.06 [-.21, .10]	–	
3. Satisfaction with the work environment	6.42	1.30	-.11 [-.26, .05]	.52** [.39, .62]	–
4. Task performance	0.00	1.65	-.06 [-.21, .10]	.19* [.04, .34]	.08 [-.08, .23]

Note. Average scores (Task 1 and Task 2) are used for perceived fit and task performance. Pearson correlation coefficients with 95% confidence intervals; * $p < .05$, ** $p < .01$.

Table 4

Results of regression analysis for perceived fit (Study 2).

Source of variation	Coefficient	95% confidence interval		p value
		Lower	Upper	
Activity	1.71	0.01	3.42	.049
Work setting	1.61	0.01	3.22	.049
Personal need for privacy (PNP)	0.21	–0.19	0.62	.298
Activity \times work setting	–1.78	–4.09	0.53	.130
Activity \times PNP	–0.73	–1.30	–0.15	.014
Work setting \times PNP	–0.42	–0.95	0.11	.117
Activity \times work setting \times PNP	0.86	0.11	1.61	.025

Note. Unstandardized regression coefficients are shown.

significant main and two-way interactions were qualified by the significant three-way interaction effect of activity \times work setting \times PNP (see Table 4). Also consistent with Study 1, follow-up analyses revealed that in the open office condition, perceived fit was negatively related to PNP ($p = .025$, see Fig. 4a). This indicates that, as expected, perceived fit between high-complexity tasks and open office work settings was particularly low among participants high in PNP. An additional two-sided *t*-test revealed that, as in Study 1, compared with the participants exposed to the private office condition ($M = 6.01$, $SD = 0.68$), the participants exposed to the open office condition ($M = 4.90$, $SD = 0.94$) were lower in perceived fit (mean difference = -1.12 , 95% CI $[-1.48, -0.75]$, $t(78) = -6.03$, $p < .001$), when performing high-complexity tasks. In Study 2, no significant slopes or differences were found in the low-complexity task condition (Fig. 4b).

6.4. Indirect effect on satisfaction with the work environment

The results showed that the expected indirect effect existed in our sample (index = 0.62 , 95% CI $[0.06, 1.19]$). The positive index value indicates that perceived fit amplifies the interactive indirect effect of activity, work setting, and PNP on satisfaction.

6.5. Indirect effect on task performance

The analysis with task performance as dependent variable provided evidence for the expected indirect effect on task performance (index = 0.37 , 95% CI $[0.01, 0.85]$). The positive index value indicates that perceived fit amplifies the interactive indirect effect of activity, work setting, and PNP on task performance.

7. General discussion

The results from both Study 1 and Study 2 consistently provide empirical support for our research model (see Fig. 1). That is, perceived fit between activity and work setting was a function of activity, work setting, and PNP, with an indirect effect on satisfaction with the work environment (Studies 1 and 2) and task performance (Study 2). More specifically, with regard to *high-complexity tasks*, both studies consistently demonstrated that outcomes were more positive for private office work settings than for open office work settings, particularly

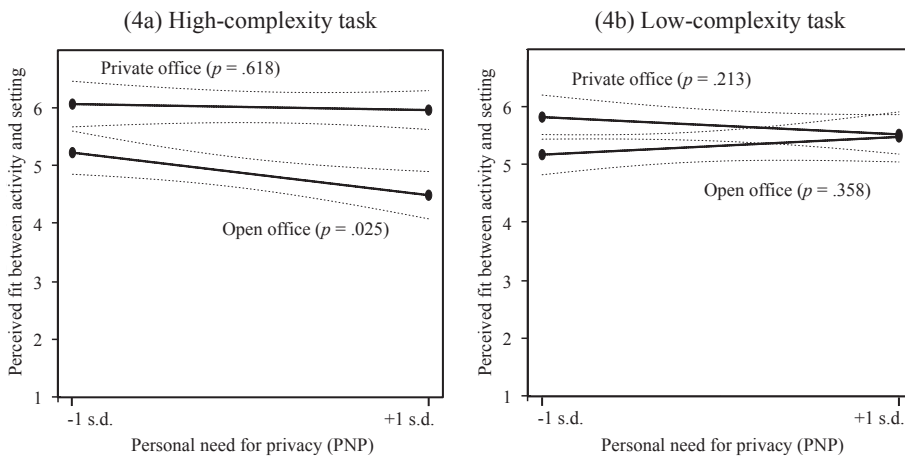


Fig. 4. Interactive effects of activity, work setting, and personal need for privacy (PNP) on perceived fit with 95% confidence bands (Study 2). On the vertical axis, perceived fit scores ranged from 1 to 6 (values and upper confidence bands exceeding 6 are a result of using the standard linear regression model, which is unbounded). The horizontal axis shows the PNP scores, ranging from 1 s.d. below to 1 s.d. above average.

Note. Slope differences were not significant for the high-complexity and the low-complexity task condition ($p = .103$ and $p = .118$ respectively). Scores for the private and open office condition differed significantly for the high-complexity task condition (mean difference = -1.12 , 95% CI $[-1.48, -0.75]$, $t(78) = 6.03$, $p < .001$), but not for the low-complexity task condition (mean difference = -0.36 , 95% CI $[-0.75, 0.03]$, $t(78) = -1.83$, $p = .071$).

when workers were high in PNP. With regard to *low-complexity tasks*, the results were less consistent across the studies. In the field study (Study 1), perceived-fit scores were lower in the private office work setting than in the open office work setting, particularly when workers were high in PNP. In contrast, in the lab study (Study 2), no significant differences were found in the low-complexity task condition.

These findings imply that in ABW environments, higher levels of satisfaction and task performance may be achieved if private office work settings are used for high-complexity tasks, rather than open office work settings; this is particularly important for workers high in PNP. Our less consistent findings with regard to low-complexity tasks indicate that further research is needed to examine if, and for whom, the use of open office work settings may be beneficial, relative to the use of private office work settings. We note that the practical relevance of this question seems limited, given the low frequency of low-complexity tasks performed in *private office* work settings (1% of the measurements).

We believe that our findings regarding perceived fit and high-complexity tasks provide an explanation for the mixed outcomes of ABW environments that were reported in previous research (Babapour, 2019; Bodin Danielsson & Bodin, 2009; Brunia et al., 2016; De Been & Beijer, 2014; Engelen et al., 2018; Göçer et al., 2018; Hoendervanger et al. 2018; Leesman, 2017; Van der Voordt, 2004). The use of *open office* work settings for high-complexity tasks was reported frequently in our field study (52% of the measurements, see Study 1). This was probably due to the observed discrepancy between the proportion of high-complexity tasks (58%) and the proportion of private office work settings (12%). ABW environments typically feature a main area in an open-plan layout where most of the work settings are located (Wohlers & Hertel, 2017), whereas around 50% of the time at the office is typically spent on tasks requiring concentration (Gensler, 2012). As a consequence, a shortage of work settings suitable for high-complexity tasks is likely to be common across organizations adopting ABW environments (see Study 1; cf., Wohlers & Hertel, 2017; Gensler, 2012). Hence, we may assume that the use of open office work settings creates perceived misfits on a wide scale, particularly among workers high in PNP. This may explain the often-reported complaints regarding lack of privacy and concentration (Babapour, 2019; Bodin Danielsson & Bodin, 2009; De Been & Beijer, 2014; Engelen et al., 2018; Van der Voordt, 2004). It may also explain why workers high in PNP were found to be the least satisfied with ABW environments (Hoendervanger et al. 2018).

7.1. Strengths and limitations

A strength of our research is that we tested and largely replicated the same research model (see Fig. 1) in a field study (Study 1) and under controlled experimental conditions (Study 2). Hence, we were

able to combine a high level of ecological validity with the assessment of causal relationships. Consistent results (i.e., with regard to perceived fit and the outcomes of high-complexity tasks) across different methodologies and participants imply considerable generalizability of our findings. Furthermore, the current research was, to the best of our knowledge, the first to use app-based experience sampling and VR simulation in ABW research. We discuss the strengths and limitations of these innovative methods below.

As demonstrated in our field study (Study 1), app-based experience sampling enables the collection of detailed and reliable data on the actual use and perception of work settings by capturing data as it happens or soon afterwards. We believe this is an important strength in the context of ABW research, as it may be difficult for workers to recall (e.g., when completing a survey) which work settings they have been using, for how long, for which activities, and how they perceived the fit at each work setting. In this respect, experience sampling is an alternative to the diary method that was used by Gerdenitsch et al. (2017) to capture similar data. Using a mobile application makes it easy for participants to respond quickly, at any place in the work environment. A potential weakness is the necessity to keep the questions brief and simple, which rules out the use of multiple-item scales. Furthermore, in Study 1, the respondents had the possibility to answer until midnight. However, as this only happened occasionally (a time gap longer than 5 h was rstered for 6% of the measurements), recall bias does not seem to be a major issue in the current research. In any case, for future experience-sampling research, we recommend shortening the maximum response time span to 1 h.

As demonstrated in Study 2, a strength of VR simulation in a well-equipped studio is that it creates a highly realistic environmental experience, with optimal control of experimental conditions. This enables testing of different work settings which are typically found in ABW environments in relation to different work activities. A weakness of the current study may be the use of tests that were rather short and not directly related to common knowledge workers' activities (e.g., answering e-mails, checking a spreadsheet, or reviewing a contract with different degrees of complexity). For future experimental ABW studies, tests may be developed and utilized that are more akin to such work activities in terms of content and time needed to complete them. Using the same standardized tests in different experimental studies, both in lab and field settings, may increase the comparability and generalizability of findings.

Finally, a strength of our research model (Fig. 1) is its focus on key variables, but excluding other factors may be perceived as a weakness as well. For example, other psychological needs, including the need for autonomy and relatedness, may also influence workers' perceptions of fit in ABW environments.

7.2. Theoretical implications

Our findings are largely in line with the core assumption of PE fit theory that perceived needs-supply fit positively affects outcomes such as satisfaction and performance (Edwards et al., 1998; Kristof-Brown et al., 2005; Vischer, 2007; Wohlers & Hertel, 2017). We extend previous findings by emphasizing that “needs” may be both person-related (i.e., PNP) and task-related (i.e., required level of privacy associated with the complexity of the task), and that “supply” includes the physical work environment. Indeed, PE fit theory seems to provide a useful framework for improving our understanding of the complex interplay of work activities, work settings, and personal characteristics in work environments. Research in ABW, in turn, may contribute to the further development of PE fit theory by acknowledging how specific (perceived) qualities of the ABW environment (e.g., availability, functionality, comfort, and aesthetic quality of different types of work settings) may be instrumental in creating PE fit.

7.3. Practical implications

Our findings demonstrate the importance of creating (perceived) fit between activity, work setting, and personal characteristics for optimizing satisfaction and task performance in ABW environments. At the same time, however, our results indicate that such a fit is far from obvious in practice. Specifically, performing high-complexity tasks in open office work settings seems to be highly prevalent, also among workers high in PNP. We see two major keys to resolving this issue, which we will discuss below: (1) *facilitating* high complexity-tasks by providing sufficient work settings that offer privacy, (2) *stimulating* the use of such work settings for high-complexity tasks by removing social, psychological, and practical barriers.

The supply of work settings that offer privacy may include private office work settings (like the ones included in the current studies), but also other types of work settings like shared ‘quiet rooms’ where (phone) conversations are not allowed (Haapakangas et al., 2018). The design of these work settings deserves special attention to ensure optimal (control of) architectural privacy (Sundstrom et al., 1980; i.e., acoustic and visual isolation). To determine how many of these work settings are needed to facilitate a specific work force, the time spent on high-complexity tasks (at the office) needs to be mapped properly first. The proportion of high-complexity tasks appears to be easily underestimated in practice. Typically, this proportion is around 50% (Gensler, 2012) and increasing due to computerization of low-complexity tasks (Duffy & Powell, 1997; Newport, 2016). In contrast, ABW environments typically offer mostly open office work settings (Wohlers & Hertel, 2017) which are not suitable for high-complexity tasks. In addition to time spent on high-complexity tasks, individual differences regarding PNP (i.e., related to psychological need and age) should also be taken into account when determining the supply of work settings that offer privacy.

If sufficient work settings that offer privacy are provided, these may still not be used for performing high-complexity tasks, as workers typically do not frequently switch between different work settings (Appel-Meulenbroek, Groenen, & Janssen, 2011; Göçer et al., 2018; Hoendervanger et al., 2018), despite the variety of the tasks that they carry out (Rothe, 2015). Important reasons *not* to switch are related to social ties and norms (e.g., staying with colleagues in an open office work setting instead of moving to a work setting that offers more privacy), psychological factors (e.g., place attachment), and practical issues (e.g., necessity to move stuff) (Hoendervanger et al., 2016). Effective measures to remove such barriers may be, for instance, discussing and changing social norms and encouraging conscious experimentation with the use of different work settings. By removing barriers to switching, workers may be stimulated to use work settings that offer privacy when appropriate, while at the same time it may increase the availability of these work settings by discouraging ‘implicit ownership’

(Babapour, 2019).

In our view, the facilitating approach and the stimulating approach should go hand in hand to achieve optimal fits between activities, work settings, and personal characteristics. This requires a joint effort of various workplace professionals, including designers, facility managers, and human resource managers. As a starting point, we recommend conducting a thorough analysis of relevant job characteristics (e.g., task variety, time spent on high-complexity tasks), personal characteristics (e.g., PNP, place attachment), and organizational characteristics (e.g., social ties and norms).

8. Conclusions

Our studies confirmed that perceived fit is a function of activity, work setting, and PNP, with indirect effects on satisfaction with the work environment (Studies 1 and 2) and task performance (Study 2). Across both studies, a misfit was perceived particularly among workers high in PNP when performing high-complexity tasks in an open office work setting.

These findings imply that the potential benefits of ABW environments in terms of satisfaction and performance may be achieved only when workers actually experience a fit between activities, work settings, and personal characteristics. Therefore, organizations and workplace professionals should facilitate and stimulate workers to create better fits, particularly among workers high in PNP when performing high-complexity tasks.

References

- Aarts, H., & Dijksterhuis, A. (2000). Habits as knowledge structures: Automaticity in goal-directed behavior. *Journal of Personality and Social Psychology*, 78(1), 53–63. <https://doi.org/10.1037/0022-3514.78.1.53>.
- Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Newbury Park, CA: Sage.
- Appel-Meulenbroek, R., Groenen, P., & Janssen, I. (2011). An end-user's perspective on activity-based office concepts. *Journal of Corporate Real Estate*, 13(2), 122–135. <https://doi.org/10.1108/14630011111136830>.
- Babapour, M. (2019). *The quest for the room of requirement – why some activity-based flexible offices work while others do not*. Gothenburg, Sweden: Doctoral thesis Chalmers University of Technology.
- Baron, R., & Kenny, D. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, stratic, and statistical considerations. *Journal of Personality and Social Psychology*, 51(6), 1173–1182. <https://doi.org/10.1037/0022-3514.51.6.1173>.
- Becker, F. (1999). Beyond alternative officing: Infrastructure on-demand. *Journal of Corporate Real Estate*, 1(2), 154–168. <https://doi.org/10.1108/14630019910811006>.
- Bedny, G., Karwowski, W., & Bedny, I. (2012). Complexity evaluation of computer-based tasks. *International Journal of Human-Computer Interaction*, 28, 236–257. <https://doi.org/10.1080/10447318.2011.581895>.
- Block, L., & Stokes, G. (1989). Performance and satisfaction in private versus nonprivate work settings. *Environment and Behavior*, 21(3), 277–297. <https://doi.org/10.1177/0013916589213003>.
- Bodin Danielsson, C., & Bodin, L. (2009). Difference in satisfaction with office environment among employees in different office types. *Journal of Architectural and Planning Research*, 26(3), 241–258.
- Brunia, S., De Been, I., & Van der Voordt, T. (2016). Accommodating new ways of working: Lessons from best practices and worst cases. *Journal of Corporate Real Estate*, 18(1), 30–47. <https://doi.org/10.1108/JCRE-10-2015-0028>.
- Bruni, C., Schultz, P., & Saunders, C. Environmental response inventory. Retrieved from www.conpsychmeasures.com/conpsychmeasures/measures/ERI/ERI.html.
- Bubany, S., & Hansen, J. (2006). Minnesota clerical test. In N. Salkind (Ed.). *Encyclopedia of measurement and statistics* (pp. 607). Sage Publications.
- Compernelle, T. (2014). The open office is naked: The fifth brainchain that ruins your intellectual productivity. *Computations*. Retrieved from <https://drive.google.com/file/u/1/d/0ByN-2lZSJqvX0pyRnZhV0c0Qm8/view?usp=sharing>.
- Cushman & Wakefield (2013). *Workplace transformation survey: A global view of workplace change*. Retrieved from <http://cwed.com/wp-content/uploads/2015/05/WorkplaceTransformation.pdf>.
- Davis, M., Leach, D., & Clegg, C. (2011). The physical environment of the office: Contemporary and emerging issues. In G. P. Hodgkinson, & K. Ford (Eds.). *International review of industrial and organizational psychology* (pp. 193–237). John Wiley & Sons Ltd. <https://doi.org/10.1002/9781119992592.ch6>.
- De Been, I., & Beijer, M. (2014). The influence of office type on satisfaction and perceived productivity support. *Journal of Facilities Management*, 12(2), 142–157. <https://doi.org/10.1108/JFM-02-2013-0011>.
- Duffy, F., & Powell, K. (1997). *The new office*. Conran Octopus.
- Edwards, J. R., Cable, D. M., Williamson, I. O., Schurer Lambert, L., & Shipp, A. J. (2006).

- The phenomenology of fit: Linking the person and environment to the subjective experience of person-environment fit. *Journal of Applied Psychology*, 91(4), 802–827. <https://doi.org/10.1037/0021-9010.91.4.802>.
- Edwards, J., Caplan, R., & Harrison, R. (1998). Person-environment fit theory: Conceptual foundations, empirical evidence, and directions for future research. In C. Cooper (Ed.), *Theories of organizational stress* (pp. 28–67). Oxford: Oxford University Press.
- Engelen, L., Chau, J., Young, S., Mackey, M., Jeyapalan, D., & Bauman, A. (2018). Is activity-based working impacting health, work performance and perceptions? A systematic review. *Building Research & Information*, 47(4), 468–479. <https://doi.org/10.1080/09613218.2018.1440958>.
- Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39, 175–191. <https://doi.org/10.3758/BF03193146>.
- Gensler (2012). *What we've learned about focus in the workplace*. Retrieved from https://www.gensler.com/uploads/document/306/file/Focus_in_the_Workplace_10_01_2012.pdf.
- Gerdenitsch, C., Korunka, C., & Hertel, G. (2017). Need-supply fit in an activity-based flexible office: A longitudinal study during relocation. *Environment and Behavior*, 1–26. <https://doi.org/10.1177/0013916517697766>.
- Gibson, V. (2003). Flexible working needs flexible space?; towards an alternative workplace strategy. *Journal of Property Investment & Finance*, 21(1), 12–22. <https://doi.org/10.1108/14635780310468275>.
- Göçer, Ö., Göçer, K., Karahan, E., & Öygür, I. (2018). Exploring mobility & workplace choice in a flexible office through post-occupancy evaluation. *Ergonomics*, 61(2), 226–242. <https://doi.org/10.1080/00140139.2017.1349937>.
- Haapakangas, A., Hongisto, V., Varjo, J., & Lahtinen, M. (2018). Benefits of quiet workspaces in open-plan offices – evidence from two office relocations. *Journal of Environmental Psychology*, 56, 63–75. <https://doi.org/10.1016/j.jenvp.2018.03.003>.
- Hackman, J., & Lawler, E. (1971). Employee reactions to job characteristics. *Journal of Applied Psychology*, 55(3), 259–286. <https://doi.org/10.1037/h0031152>.
- Hadfield, J. (2010). MCMC methods for multi-response generalized linear mixed models: The MCMCglmm R package. *Journal of Statistical Software*, 33(2), 1–22. <https://doi.org/10.18637/jss.v033.i02>.
- Hayes, A. F. (2017a). Introduction to mediation, moderation, and conditional process analysis. *A regression-based approach* (2nd ed.). Guilford Publications.
- Hayes, A. F. (2017b). Partial, conditional, and moderated moderated mediation: Quantification, inference, and interpretation. *Communication Monographs*, 85(1), 4–40. <https://doi.org/10.1080/03637751.2017.1352100>.
- Hockey, G. R. J. (1979). Stress and the cognitive components of skilled performance. In V. Hamilton, & D. M. Warburton (Eds.), *Human stress and cognition: An information processing approach* (pp. 141–177). New York: John Wiley & Sons.
- Hoendervanger, J. G., De Been, I., Van Yperen, N., Mobach, M., & Albers, C. (2016). Flexibility in Use: Switching behaviour and satisfaction in activity-based work environments. *Journal of Corporate Real Estate*, 18(1), 48–62. <https://doi.org/10.1108/JCRE-10-2015-0033>.
- Hoendervanger, J. G., Ernst, A., Albers, C., Van Yperen, N., & Mobach, M. (2018). Individual differences in satisfaction with activity-based work environments. *PLoS ONE*, 13(3), 1–15. <https://doi.org/10.1371/journal.pone.0193878>.
- Hoendervanger, J. G., Le Noble, V., Mobach, M., & Van Yperen, N. (2015). Tool development for measuring and optimizing workplace utilization in activity-based work environments. *European Facility Management Conference, Glasgow: EuroFM*.
- Jones Lang Lasalle (2012). *Activity based working*. Retrieved from: <http://www.jll.com.au/australia/en-au/Documents/jll-au-activity-based-working-2012.pdf>.
- Kaarlela-Tuomaala, A., Helenius, R., Keskinen, E., & Hongisto, V. (2009). Effects of acoustic environment on work in private office rooms and open-plan offices: Longitudinal study during relocation. *Ergonomics*, 52(11), 1423–1444. <https://doi.org/10.1080/00140130903154579>.
- Kim, J., & De Dear, R. (2013). Workspace satisfaction: The privacy-communication trade-off in open-plan offices. *Journal of Environmental Psychology*, 36, 18–26. <https://doi.org/10.1016/j.jenvp.2013.06.007>.
- Kristof-Brown, A., & Guay, R. (2011). Person-environment fit. In S. Zedeck (Vol. Ed.), *Handbook of industrial and organizational psychology: Vol. 3*, (pp. 3–50). American Psychological Association.
- Kristof-Brown, A., Zimmerman, R., & Johnson, E. (2005). Consequences of individuals' fit at work: A meta-analysis of person-job, person-organization, person-group and person-supervisor fit. *Personnel Psychology*, 281–342. <https://doi.org/10.1111/j.1744-6570.2005.00672.x>.
- Kupritz, V. (1998). Privacy in the work place: The impact of building design. *Journal of Environmental Psychology*, 18, 341–356. <https://doi.org/10.1006/jenvp.1998.0081>.
- Larson, R., & Csikszentmihalyi, M. (1983). The experience sampling method. In H. Reis (Vol. Ed.), *New directions for methodology of social and behavioral Sciences: Vol. 15*, (pp. 41–56). San Francisco: Jossey-Bass.
- Leesman (2017). *The rise and rise of activity based working*. Retrieved from http://www.leesmanindex.com/The_Rise_and_Rise_of_Activity_Based_Working_Research_book.pdf.
- Loomis, J., Blascovich, J., & Beall, A. (1999). Immersive virtual environment technology as a basic research tool in psychology. *Behavior Research Methods, Instruments, & Computers*, 31(4), 557–564. <https://doi.org/10.3758/BF03200735>.
- Maarleveld, M., Volker, L., & Van der Voordt, T. (2009). Measuring employee satisfaction in new offices - the WODI toolkit. *Journal of Facilities Management*, 7(3), 181–197. <https://doi.org/10.1108/14725960910971469>.
- Mahler, A., & Von Hippel, C. (2005). Individual differences in employee reactions to open-plan offices. *Journal of Environmental Psychology*, 25, 219–229. <https://doi.org/10.1016/j.jenvp.2005.05.002>.
- McBain, W. (1961). Noise, the "arousal hypothesis", and monotonous work. *Journal of Applied Psychology*, 45(5), 309–317. <https://doi.org/10.1037/h0049015>.
- McClelland, D., & Burnham, D. (1976). Power is the great motivator. *Harvard Business Review*, (54), 100–110.
- McKechnie, G. (1977). The environmental response inventory in application. *Environment and Behavior*, 9(2), 255–276. <https://doi.org/10.1177/001391657792006>.
- Newport, C. (2016). *Deep work*. New York: Grand Central Publishing.
- Oldham, G. (1988). Effects of changes in workspace partitions and spatial density: A quasi-experiment. *Journal of Applied Psychology*, 253–258. <https://doi.org/10.1037/0021-9010.73.2.253>.
- Oseland, N. (2009). The impact of psychological needs on office design. *Journal of Corporate Real Estate*, 11(4), 244–254. <https://doi.org/10.1108/14630010911006738>.
- R Core Team (2015). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing.
- Rothe, P. (2015). Flexibility and variety hold the key as employees' activity profiles become more complex. *Leesman review*, 18. Retrieved from <https://www.leesmanindex.com/wp-content/uploads/Leesman-Review-Issue-18.pdf>.
- Seddigh, A., Berntson, E., Bodin Danielson, C., & Westerlund, H. (2014). Concentration requirements modify the effect of office type on indicators of health and performance. *Journal of Environmental Psychology*, 38, 167–174. <https://doi.org/10.1016/j.jenvp.2014.01.009>.
- Shiffman, S., Stone, A., & Hufford, M. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology*, (4), 1–32. <https://doi.org/10.1146/annurev.clinpsy.3.022806.091415>.
- Smith, J. (2015). Immersive virtual environment technology to supplement environmental perception, preference and behavior research: A review with applications. *International Journal of Environmental Research and Public Health*, 12, 11486–11505. <https://doi.org/10.3390/ijerph120911486>.
- Staal, M. A. (2004). Stress, cognition, and human performance: A literature review and conceptual framework. *NASA Ames Research Center*. Retrieved from <https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20060017835.pdf>.
- Sundstrom, E., Burt, R., & Kamp, D. (1980). Privacy at work: Architectural correlates of job satisfaction and job performance. *Academy of Management Journal*, 23(1), 101–117. <https://doi.org/10.2307/255498>.
- Totterdell, P. (2006). Longitudinal research/experience sampling technique. In G. Rogelberg (Ed.), *Encyclopedia of industrial and organizational psychology* (pp. 462–465). EBSCO Publishing/Sage Publications.
- Van Yperen, N., & Wörtler, B. (2017). Blended working. In G. Hertel, D. Stone, R. Johnson, & J. Passmore (Eds.), *The Wiley-Blackwell handbook of the psychology of the internet at work* (pp. 157–174). Chichester: Wiley-Blackwell.
- Van der Voordt, T. (2004). Productivity and employee satisfaction in flexible workplaces. *Journal of Corporate Real Estate*, 6(2), 133–148. <https://doi.org/10.1108/14630010410812306>.
- Veldhoen, E. (2005). *The art of working*. Academic Service.
- Vischer, J. C. (2007). The effects of the physical environment on job performance: Towards a theoretical model of workplace stress. *Stress and Health*, 23(3), 175–184. <https://doi.org/10.1002/smi.1134>.
- Wanous, J., Reichers, A., & Hurd, M. (1997). Overall job satisfaction: How good are single-item measures? *Journal of Applied Psychology*, 82(2), 247–252. <https://doi.org/10.1037/0021-9010.82.2.247>.
- Wohlens, C., Hartner-Tiefenthaler, M., & Hertel, G. (2017). The relation between activity-based work environments and office workers' job attitudes and vitality. *Environment and Behavior*, 1–32. <https://doi.org/10.1177/0013916517738078>.
- Wohlens, C., & Hertel, G. (2017). Choosing where to work at work: Towards a theoretical model of benefits and risks of activitybased flexible offices. *Ergonomics*, 60(4), 467–486. <https://doi.org/10.1080/00140139.2016.1188220>.